

CLAIMS

1. An article comprising:  
a fiber bundle formed of a plurality of fibers, at least about 5% of the plurality of  
5 fibers comprising fibers having a tensile breaking strength of at least about 10 g/Denier,  
the fiber bundle being constructed such that upon exposure to a fabric dye, the fiber  
bundle is dyed to an essentially visually uniform color density.
2. The article as in claim 1, wherein at least about 10% of the plurality of fibers  
10 comprise fibers having a tensile breaking strength of at least about 10 g/Denier.
3. The article as in claim 2, wherein at least about 20% of the plurality of fibers  
comprise fibers having a tensile breaking strength of at least about 10 g/Denier.
- 15 4. The article as in claim 3, wherein at least about 50% of the plurality of fibers  
comprise fibers having a tensile breaking strength of at least about 10 g/Denier.
5. The article as in claim 4, wherein at least about 65% of the plurality of fibers  
comprise fibers having a tensile breaking strength of at least about 10 g/Denier.  
20
6. The article as in claim 5, wherein at least about 75% of the plurality of fibers  
comprise fibers having a tensile breaking strength of at least about 10 g/Denier.
7. The article as in claim 6, wherein at least about 85% of the plurality of fibers  
25 comprise fibers having a tensile breaking strength of at least about 10 g/Denier.
8. The article as in claim 1, wherein the at least about 5% of the plurality of fibers  
comprising fibers having a tensile breaking strength of at least about 10 g/Denier are  
formed of a material selected from the group consisting of: para-aramids; liquid crystal  
30 polyesters; ultra-high molecular weight polyethylenes; and poly(p-phenylene-2,6-  
benzobisoxazole) (PBO).

9. The article as in claim 1, wherein at least about 5% of the plurality of fibers comprise fibers having a tensile breaking strength of at least about 15 g/Denier.

10. The article as in claim 9, wherein at least about 5% of the plurality of fibers  
5 comprise fibers having a tensile breaking strength of at least about 20 g/Denier.

11. The article as in claim 10, wherein at least about 10% of the plurality of fibers comprise fibers having a tensile breaking strength of at least about 10g/Denier.

10 12. The article as in claim 11, wherein at least about 5% of the plurality of fibers comprise fibers having a tensile breaking strength of at least about 30 g/Denier.

13. The article as in claim 1, wherein at least one fiber of the plurality has a tensile breaking strength of less than about 10 g/Denier.

15 14. The article as in claim 13, wherein at least one fiber of the plurality has a tensile breaking strength of less than about 8 g/Denier.

15. The article as in claim 14, wherein at least one fiber of the plurality has a tensile  
20 breaking strength of less than about 5 g/Denier.

16. The article as in claim 15, wherein at least one fiber of the plurality has a tensile breaking strength of less than about 3 g/Denier.

25 17. The article as in claim 13, wherein the at least one fiber of the plurality having a tensile breaking strength of less than about 10 g/Denier is formed of a material selected from the group consisting of: polyamides; cellulosic materials; polyesters; acrylic polymers; and polyolefins.

30 18. The article as in claim 1, wherein the fabric dye is selected from the group consisting of: cationic dyes; anionic dyes; and polyester dyes.

19. The article as in claim 1, wherein the fiber bundle is formed of a plurality of spun staple fibers.

20. The article as in claim 19, wherein the fiber bundle is formed by a Cotton System spinning process and the length of the staple fibers does not exceed about 2 inches.

21. The article as in claim 19, wherein the fiber bundle is formed by a Worsted System spinning process and the length of the staple fibers exceeds about 2 inches.

22. The article as in claim 19, wherein the fiber bundle has a primary twist multiplier of at least about 2.7.

23. The article as in claim 22, wherein the fiber bundle has a primary twist multiplier of at least about 3.

24. The article as in claim 23, wherein the fiber bundle has a primary twist multiplier of at least about 3.5.

25. The article as in claim 24, wherein the fiber bundle has a primary twist multiplier of at least about 4.

26. The article as in claim 25, wherein the fiber bundle has a primary twist multiplier of at least about 4.5.

27. The article as in claim 26, wherein the fiber bundle has a primary twist multiplier of at least about 5.

28. The article as in claim 19, wherein any given cross-section of the fiber bundle along its length includes therein between about 60 and about 100 fibers.

29. The article as in claim 1, wherein the fabric dye and essentially visually uniform color density of the dyed fiber bundle are lighter in color than the undyed color of at least

one fiber of the plurality of fibers comprising fibers having a tensile breaking strength of at least about 10 g/Denier.

30. A plied yarn comprising:

- 5 a first fiber bundle comprising the fiber bundle as recited in claim 1; and  
at least a second fiber bundle plied together with the first fiber bundle.

31. The plied yarn as in claim 30, wherein the second fiber bundle is substantially similar in composition and construction to the first fiber bundle.

10

32. The plied yarn as in claim 30, wherein the plied yarn is characterized by a secondary ply twist of at least about  $\frac{1}{4}$  that of a primary twist of the first fiber bundle and the second fiber bundle.

15

33. The plied yarn as in claim 32, wherein the plied yarn is characterized by a secondary ply twist of at least about  $\frac{1}{2}$  that of a primary twist of the first fiber bundle and the second fiber bundle.

20

34. The plied yarn as in claim 33, wherein the plied yarn is characterized by a secondary ply twist of at least about equal to that of a primary twist of the first fiber bundle and the second fiber bundle.

35. A woven fabric at least partly formed of the fiber bundle as recited in claim 1.

25

36. An article of apparel at least partly formed of the woven fabric as recited in claim 35.

30

37. The article of apparel as in claim 36, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.

38. A method comprising the step of:

dyeing a fiber bundle formed of a plurality of fibers, at least about 5% of the plurality of fibers comprising high tenacity fibers having a tensile breaking strength of at least about 10g/Denier, with a fabric dye to form a dyed fiber bundle having an essentially visually uniform dye color density.

5

39. A method comprising the steps of:

pre-washing roll stock of a fabric that includes at least one fiber of a first type having a tensile breaking strength of at least about 10 g/Denier; and

10 increasing the puncture resistance of the fabric in comparison to the puncture resistance of the fabric prior to the pre-washing step.

40. The method as in claim 39, wherein the fiber of the first type has a tensile breaking strength of at least about 15 g/Denier.

15 41. The method as in claim 40, wherein the fiber of the first type has a tensile breaking strength of at least about 20 g/Denier.

42. The method as in claim 41, wherein the fiber of the first type has a tensile breaking strength of at least about 25 g/Denier.

20

43. The method as in claim 42, wherein the fiber of the first type has a tensile breaking strength of at least about 30 g/Denier.

25 44. The method as in claim 39, wherein the fiber of the first type is formed of a material selected from the group consisting of: para-aramids; liquid crystal polyesters; ultra-high molecular weight polyethylenes; and poly(p-phenylene-2,6-benzobisoxazole) (PBO).

30 45. The method as in claim 39, wherein the fabric consists essentially of fibers having a tensile breaking strength of at least about 10 g/Denier.

46. The method as in claim 39, wherein the fabric is a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns.

47. The method as in claim 46, wherein the woven fabric has a fill yarn cover factor of at least about 75% and a warp yarn cover factor of at least about 100%.

5 48. The method as in claim 47, wherein the woven fabric has a fill yarn cover factor of at least about 80%.

49. The method as in claim 48, wherein the woven fabric has a fill yarn cover factor of at least about 85%.

10

50. The method as in claim 49, wherein the woven fabric has a fill yarn cover factor of at least about 88%.

15

51. The method as in claim 50, wherein the woven fabric has a warp yarn cover factor of at least about 110%.

52. The method as in claim 51, wherein the woven fabric has a warp yarn cover factor of at least about 120%.

20

53. The method as in claim 52, wherein the woven fabric has a warp yarn cover factor of at least about 130%.

54. The method as in claim 53, wherein the woven fabric has a warp yarn cover factor of at least about 140%.

25

55. The method as in claim 54, wherein the woven fabric has a warp yarn cover factor of at least about 145%.

30

56. The method as in claim 55, wherein the woven fabric has a warp yarn cover factor of at least about 150%.

57. The method as in claim 39, wherein the pre-washing step increases the puncture resistance of the fabric by at least about 5%.

58. The method as in claim 57, wherein the pre-washing step increases the puncture resistance of the fabric by at least about 10%.

5 59. The method as in claim 58, wherein the pre-washing step increases the puncture resistance of the fabric by at least about 15%.

60. The method as in claim 59, wherein the pre-washing step increases the puncture resistance of the fabric by at least about 20%.

10

61. The method as in claim 60, wherein the pre-washing step increases the puncture resistance of the fabric by at least about 25%.

15 62. The method as in claim 39, wherein the pre-washing step decreases the bending stiffness of the fabric by at least about 5%.

63. The method as in claim 62, wherein the pre-washing step decreases the bending stiffness of the fabric by at least about 10%.

20 64. The method as in claim 63, wherein the pre-washing step decreases the bending stiffness of the fabric by at least about 15%.

65. The method as in claim 64, wherein the pre-washing step decreases the bending stiffness of the fabric by at least about 20%.

25

66. The method as in claim 65, wherein the pre-washing step decreases the bending stiffness of the fabric by at least about 25%.

30 67. The method as in claim 39, wherein the pre-washing step comprises the steps of:  
saturating the fabric with an aqueous solution of a surfactant; and  
subjecting the fabric to mechanical flexing and agitation.

68. The method as in claim 67, wherein the subjecting step has a duration of between about 1 and about 5 hours.

69. The method as in claim 67, wherein the subjecting step is performed with a drum  
5 washing machine.

70. The method as in claim 39, further comprising the step of:  
dyeing the fabric to an essentially visually uniform dye color density.

10 71. The method as in claim 39, further comprising after the pre-wash step, the step  
of:  
drying the fabric.

15 72. The method as in claim 71, further comprising after the pre-wash step, the step  
of:  
assembling the fabric into an article of apparel.

20 73. The method as in claim 72, wherein the article of apparel is selected from the  
group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats;  
socks; shoes; undergarments; vests; waders; hats; and gauntlets.